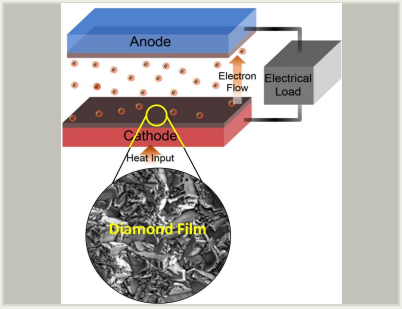
Development of an Advanced Diamond TEC Cathode, Phase I

Completed Technology Project (2016 - 2017)

Project Introduction

NASA recognizes the importance of conservation, smart utilization and reuse of resources for their deep space missions to address the need for regeneration of air, water and waste with highly reliable systems to reduce mission payload. Additionally, energy for life support and other systems needs to be obtained from renewable energy sources or waste streams. In order to address NASA's requirements of harnessing renewable energy and utilizing waste heat, IOP Technologies and Vanderbilt University propose to design and develop advanced TEC cathodes based on diamond films synthesized on flexible metallic substrates. These cathodes can not only leverage solar energy on Mars by using solar concentrators, but also use wasted thermal energy from other power sources to augment power generation. This technology can provide an efficient way of converting thermal energy into electrical energy. Studies have shown that TEC can approach total energy conversion efficiencies within 90% of the Carnot limit. As part of the proposed efforts in this STTR program, metal foil substrates such Molybdenum will be used to grow diamond thin-films in microwave plasma enhanced CVD (MPECVD) system. Diamond properties such as microstructure, electrical conductivity, quality, grain size and size distribution can be varied by adjusting the MPECVD growth parameters. The selection of diamond as the rugged and efficient emitter material is based on the excellent material properties such as negative electron affinity, low work function (less than 2eV), wide band gap (5.45eV), highest thermal conductivity (~5x that of Cu), highest Young?s modulus (~5x that of 306 stainless steel), inherently radiation hardened, highest breakdown voltage (~10 exp7 V per cm). Preliminary results from IOP research show a maximum output power of ~1mW per sq. cm at less than 100 torr pressure of hydrogen was achieved using a Diamond/Mo TEC Cathode and can be increased to 100mW per sq. cm.



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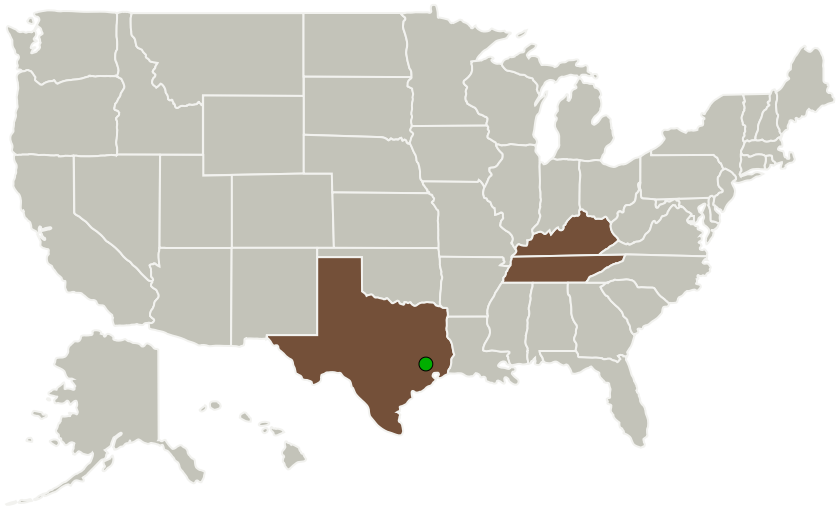
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
IOP Technologies LLC	Lead Organization	Industry	Louisville, Kentucky
Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas
Vanderbilt University	Supporting Organization	Academia	Nashville, Tennessee

Primary U.S. Work Locations	
Kentucky	Tennessee
Texas	

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

IOP Technologies LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

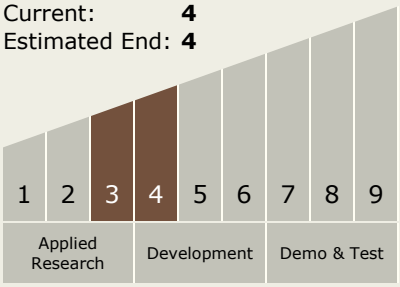
Carlos Torrez

Principal Investigator:

Weng P Kang

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



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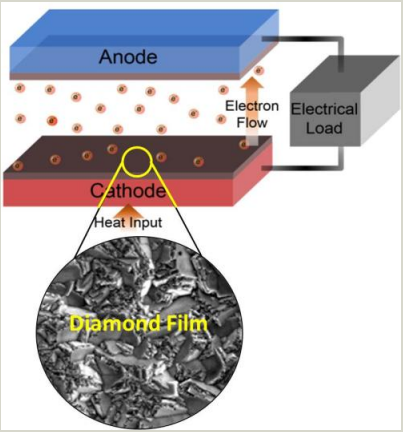
Images



Briefing Chart Image
Development of an Advanced Diamond TEC Cathode, Phase I
(https://techport.nasa.gov/image/135360)

Technology Areas

Primary:

- TX03 Aerospace Power and Energy Storage
  - TX03.1 Power Generation and Energy Conversion
    - TX03.1.4 Dynamic Energy Conversion

Target Destinations

The Moon, Mars, Outside the Solar System, The Sun, Earth, Others Inside the Solar System